

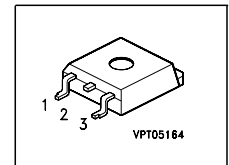
**Cool MOS™ Power Transistor**

|                     |      |          |
|---------------------|------|----------|
| $V_{DS} @ T_{jmax}$ | 560  | V        |
| $R_{DS(on)}$        | 0.19 | $\Omega$ |
| $I_D$               | 21   | A        |

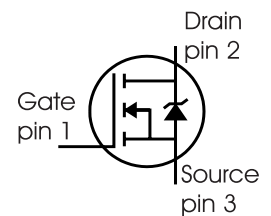
**Feature**

- New revolutionary high voltage technology
- Ultra low gate charge
- Periodic avalanche rated
- Extreme  $dv/dt$  rated
- Ultra low effective capacitances
- Improved transconductance
- Qualified according to JEDEC<sup>0)</sup> for target applications

PG-TO263



| Type       | Package  | Ordering Code | Marking |
|------------|----------|---------------|---------|
| SPB21N50C3 | PG-TO263 | Q67040-S4566  | 21N50C3 |


**Maximum Ratings**

| Parameter  | Symbol             | Value      |  | Unit             |
|--|--------------------|------------|--|------------------|
|  |                    | SPB        |  |                  |
| Continuous drain current<br>$T_C = 25\text{ }^\circ\text{C}$<br>$T_C = 100\text{ }^\circ\text{C}$                | $I_D$              | 21<br>13.1 |  | A                |
| Pulsed drain current, $t_p$ limited by $T_{jmax}$  | $I_D \text{ puls}$ | 63         |  | A                |
| Avalanche energy, single pulse<br>$I_D=10\text{A}, V_{DD}=50\text{V}$  | $E_{AS}$           | 690        |  | mJ               |
| Avalanche energy, repetitive $t_{AR}$ limited by $T_{jmax}$ <sup>2)</sup><br>$I_D=21\text{A}, V_{DD}=50\text{V}$ | $E_{AR}$           | 1          |  |                  |
| Avalanche current, repetitive $t_{AR}$ limited by $T_{jmax}$   | $I_{AR}$           | 21         |  | A                |
| Gate source voltage  | $V_{GS}$           | $\pm 20$   |  | V                |
| Gate source voltage AC ( $f > 1\text{Hz}$ )  | $V_{GS}$           | $\pm 30$   |  |                  |
| Power dissipation, $T_C = 25\text{ }^\circ\text{C}$  | $P_{tot}$          | 208        |  | W                |
| Operating and storage temperature  | $T_j, T_{stg}$     | -55...+150 |  | $^\circ\text{C}$ |
| Reverse diode $dv/dt$ <sup>7)</sup>  | $dv/dt$            | 15         |  | V/ns             |

**Maximum Ratings**

| Parameter   | Symbol  | Value | Unit |
|---|---------|-------|------|
| Drain Source voltage slope<br>$V_{DS} = 400\text{ V}$ , $I_D = 21\text{ A}$ , $T_j = 125\text{ °C}$ | $dv/dt$ | 50    | V/ns |

**Thermal Characteristics**

| Parameter   | Symbol               | Values |      |      | Unit |
|---|----------------------|--------|------|------|------|
|   |                      | min.   | typ. | max. |      |
| Thermal resistance, junction - case   | $R_{thJC}$           | -      | -    | 0.6  | K/W  |
| Thermal resistance, junction - case, FullPAK  | $R_{thJC\text{ FP}}$ | -      | -    | 3.6  |      |
| Thermal resistance, junction - ambient, leaded  | $R_{thJA}$           | -      | -    | 62   |      |
| Thermal resistance, junction - ambient, FullPAK   | $R_{thJA\text{ FP}}$ | -      | -    | 80   |      |
| SMD version, device on PCB:<br>@ min. footprint<br>@ 6 cm <sup>2</sup> cooling area <sup>3)</sup>   | $R_{thJA}$           | -      | -    | 62   |      |
|   |                      | -      | 35   | -    |      |
| Soldering temperature, reflow soldering, MSL1<br>1.6 mm (0.063 in.) from case for 10s <sup>4)</sup> | $T_{sold}$           | -      | -    | 260  | °C   |

**Electrical Characteristics, at  $T_j=25\text{ °C}$  unless otherwise specified**

| Parameter                                   | Symbol        | Conditions   | Values |      |      | Unit     |
|---|---------------|--|--------|------|------|----------|
|   |               |  | min.   | typ. | max. |          |
| Drain-source breakdown voltage              | $V_{(BR)DSS}$ | $V_{GS}=0V$ , $I_D=0.25mA$   | 500    | -    | -    | V        |
| Drain-Source avalanche<br>breakdown voltage | $V_{(BR)DS}$  | $V_{GS}=0V$ , $I_D=21A$  | -      | 600  | -    |          |
| Gate threshold voltage                      | $V_{GS(th)}$  | $I_D=1000\mu A$ , $V_{GS}=V_D$   | 2.1    | 3    | 3.9  |          |
| Zero gate voltage drain current             | $I_{DSS}$     | $V_{DS}=500V$ , $V_{GS}=0V$ ,<br>$T_j=25\text{ °C}$<br>$T_j=150\text{ °C}$ | -      | 0.1  | 1    | $\mu A$  |
|   |               |  | -      | -    | 100  |          |
| Gate-source leakage current                 | $I_{GSS}$     | $V_{GS}=20V$ , $V_{DS}=0V$   | -      | -    | 100  | nA       |
| Drain-source on-state resistance            | $R_{DS(on)}$  | $V_{GS}=10V$ , $I_D=13.1A$<br>$T_j=25\text{ °C}$<br>$T_j=150\text{ °C}$    | -      | 0.16 | 0.19 | $\Omega$ |
|   |               |  | -      | 0.54 | -    |          |
| Gate input resistance                       | $R_G$         | $f=1MHz$ , open drain  | -      | 0.53 | -    |          |

**Electrical Characteristics**

| Parameter   | Symbol       | Conditions   | Values |      |      | Unit |
|---|--------------|--|--------|------|------|------|
|   |              |  | min.   | typ. | max. |      |
| Transconductance  | $g_{fs}$     | $V_{DS} \geq 2 \cdot I_D \cdot R_{DS(on)max}$ ,<br>$I_D = 13.1A$ | -      | 18   | -    | S    |
| Input capacitance   | $C_{iss}$    | $V_{GS} = 0V$ , $V_{DS} = 25V$ ,                                 | -      | 2400 | -    | pF   |
| Output capacitance  | $C_{oss}$    | $f = 1MHz$   | -      | 1200 | -    |      |
| Reverse transfer capacitance                                  | $C_{rss}$    |  | -      | 30   | -    |      |
| Effective output capacitance, <sup>5)</sup><br>energy related | $C_{o(er)}$  | $V_{GS} = 0V$ , $V_{DS} = 400V$                                  | -      | 87   | -    |      |
| Effective output capacitance, <sup>6)</sup><br>time related   | $C_{o(tr)}$  |  | -      | 181  | -    |      |
| Turn-on delay time  | $t_{d(on)}$  | $V_{DD} = 380V$ , $V_{GS} = 0/10V$ ,                             | -      | 10   | -    | ns   |
| Rise time   | $t_r$        | $I_D = 21A$ ,  | -      | 5    | -    |      |
| Turn-off delay time   | $t_{d(off)}$ | $R_G = 3.6\Omega$  | -      | 67   | -    |      |
| Fall time   | $t_f$        |  | -      | 4.5  | -    |      |

**Gate Charge Characteristics**

|                       |                 |  |   |    |   |    |
|-----------------------|-----------------|--|---|----|---|----|
| Gate to source charge | $Q_{gs}$        | $V_{DD} = 380V$ , $I_D = 21A$                            | - | 10 | - | nC |
| Gate to drain charge  | $Q_{gd}$        |  | - | 50 | - |    |
| Gate charge total     | $Q_g$           | $V_{DD} = 380V$ , $I_D = 21A$ ,<br>$V_{GS} = 0$ to $10V$ | - | 95 | - |    |
| Gate plateau voltage  | $V_{(plateau)}$ | $V_{DD} = 380V$ , $I_D = 21A$                            | - | 5  | - | V  |

<sup>0</sup>J-STD20 and JESD22

<sup>1</sup>Limited only by maximum temperature

<sup>2</sup>Repetitive avalanche causes additional power losses that can be calculated as  $P_{AV} = E_{AR} \cdot f$ .

<sup>3</sup>Device on 40mm\*40mm\*1.5mm epoxy PCB FR4 with 6cm<sup>2</sup> (one layer, 70 μm thick) copper area for drain connection. PCB is vertical without blown air.

<sup>4</sup>Soldering temperature for TO-263: 220°C, reflow

<sup>5</sup> $C_{o(er)}$  is a fixed capacitance that gives the same stored energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$ .

<sup>6</sup> $C_{o(tr)}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$ .

<sup>7</sup> $I_{SD} \leq I_D$ ,  $di/dt \leq 200A/\mu s$ ,  $V_{DClink} = 400V$ ,  $V_{peak} < V_{BR, DSS}$ ,  $T_j < T_{j,max}$ .

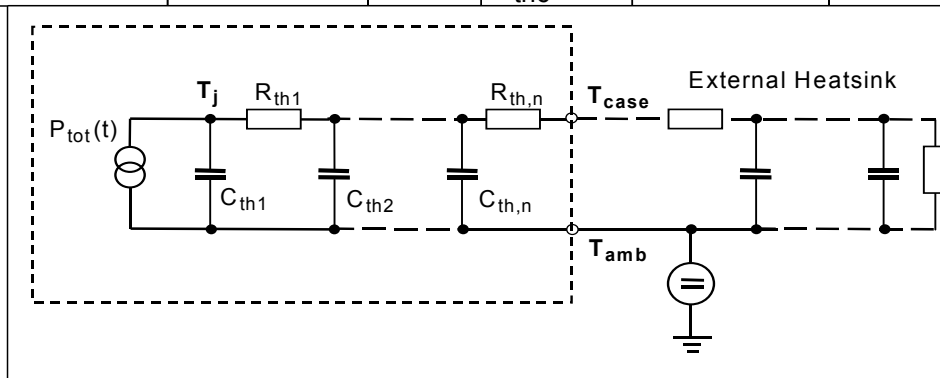
Identical low-side and high-side switch.

**Electrical Characteristics**

| Parameter                                     | Symbol       | Conditions                        | Values |      |      | Unit                   |
|---|--------------|-----------------------------------|--------|------|------|------------------------|
|   |              |                                   | min.   | typ. | max. |                        |
| Inverse diode continuous forward current      | $I_S$        | $T_C=25^\circ\text{C}$            | -      | -    | 21   | A                      |
| Inverse diode direct current, pulsed          | $I_{SM}$     |                                   | -      | -    | 63   |                        |
| Inverse diode forward voltage                 | $V_{SD}$     | $V_{GS}=0\text{V}, I_F=I_S$       | -      | 1    | 1.2  | V                      |
| Reverse recovery time                         | $t_{rr}$     | $V_R=380\text{V}, I_F=I_S,$       | -      | 450  | -    | ns                     |
| Reverse recovery charge                       | $Q_{rr}$     | $di_F/dt=100\text{A}/\mu\text{s}$ | -      | 9    | -    | $\mu\text{C}$          |
| Peak reverse recovery current                 | $I_{rrm}$    |                                   | -      | 60   | -    | A                      |
| Peak rate of fall of reverse recovery current | $di_{rr}/dt$ | $T_j=25^\circ\text{C}$            | -      | 1200 | -    | $\text{A}/\mu\text{s}$ |

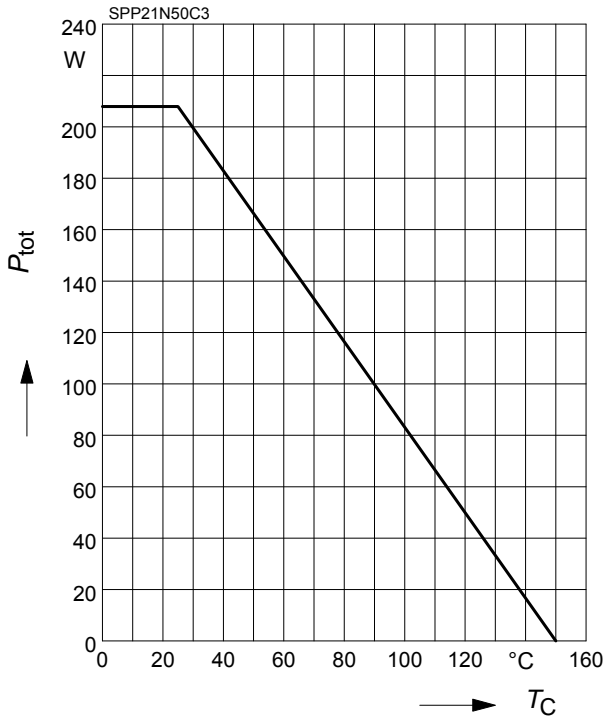
**Typical Transient Thermal Characteristics**

| Symbol    | Value   |  | Unit | Symbol    | Value     |  | Unit |
|-----------|---------|--|------|-----------|-----------|--|------|
|           | SPB     |  |      |           | SPB       |  |      |
| $R_{th1}$ | 0.00769 |  | K/W  | $C_{th1}$ | 0.0003763 |  | Ws/K |
| $R_{th2}$ | 0.015   |  |      | $C_{th2}$ | 0.001411  |  |      |
| $R_{th3}$ | 0.029   |  |      | $C_{th3}$ | 0.001931  |  |      |
| $R_{th4}$ | 0.114   |  |      | $C_{th4}$ | 0.005297  |  |      |
| $R_{th5}$ | 0.136   |  |      | $C_{th5}$ | 0.012     |  |      |
| $R_{th6}$ | 0.059   |  |      | $C_{th6}$ | 0.091     |  |      |



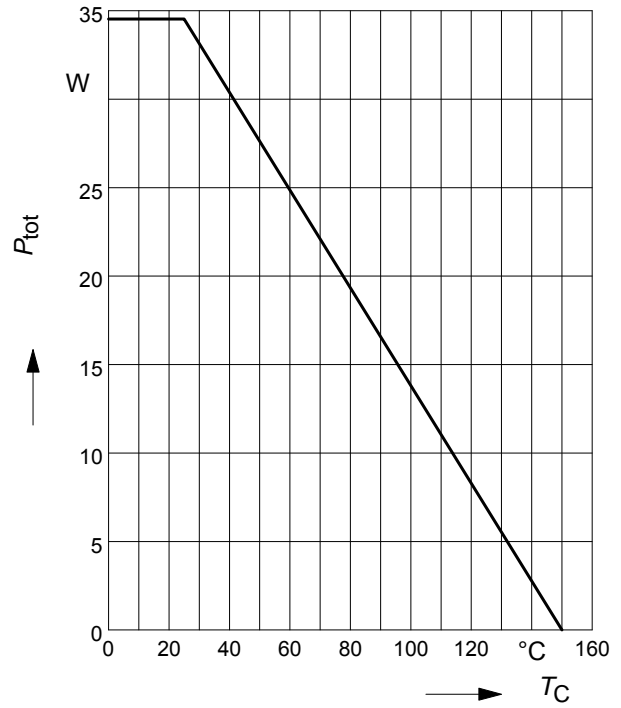
**1 Power dissipation**

$P_{tot} = f(T_C)$



**2 Power dissipation FullPAK**

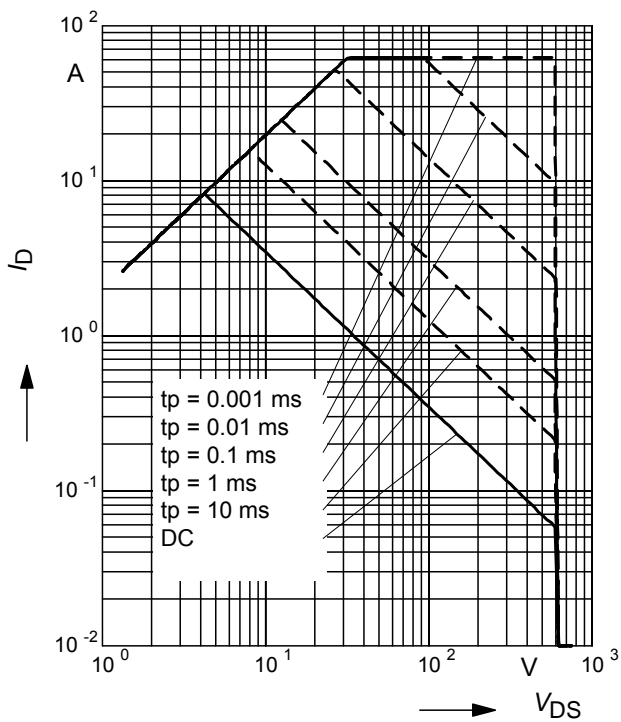
$P_{tot} = f(T_C)$



**3 Safe operating area**

$I_D = f(V_{DS})$

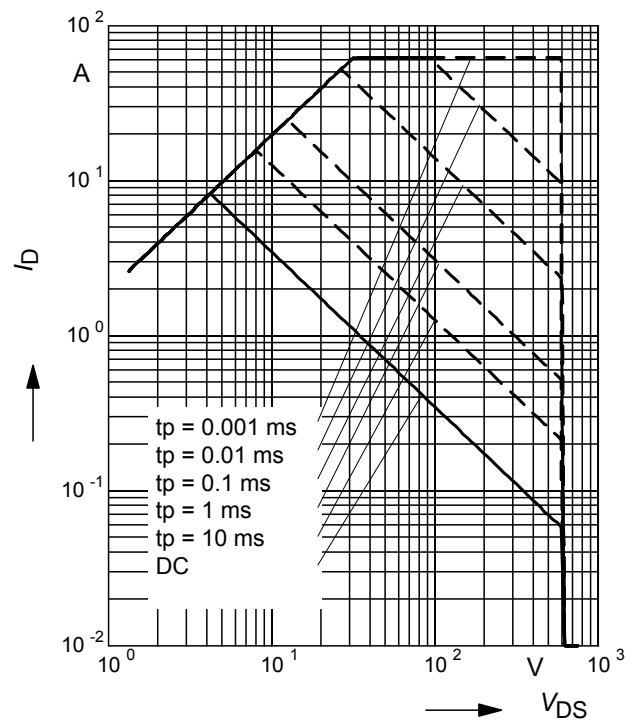
parameter :  $D = 0$  ,  $T_C = 25^\circ\text{C}$



**4 Safe operating area FullPAK**

$I_D = f(V_{DS})$

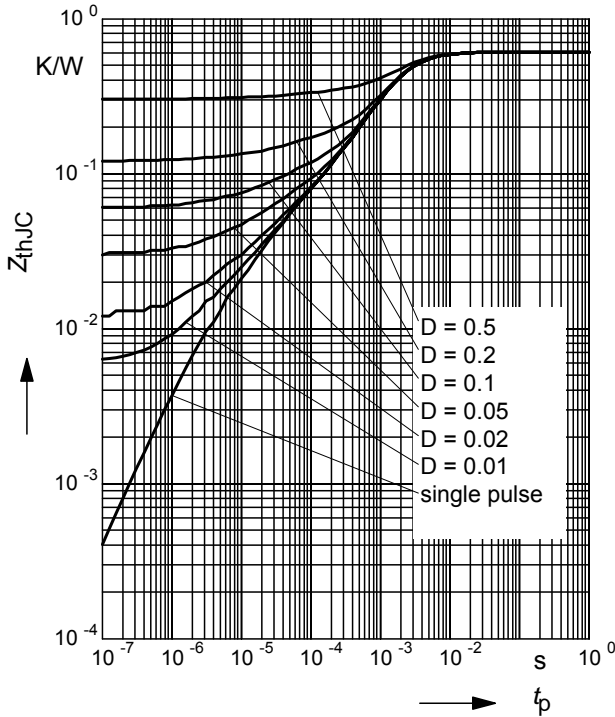
parameter:  $D = 0$  ,  $T_C = 25^\circ\text{C}$



**5 Transient thermal impedance**

$Z_{thJC} = f(t_p)$

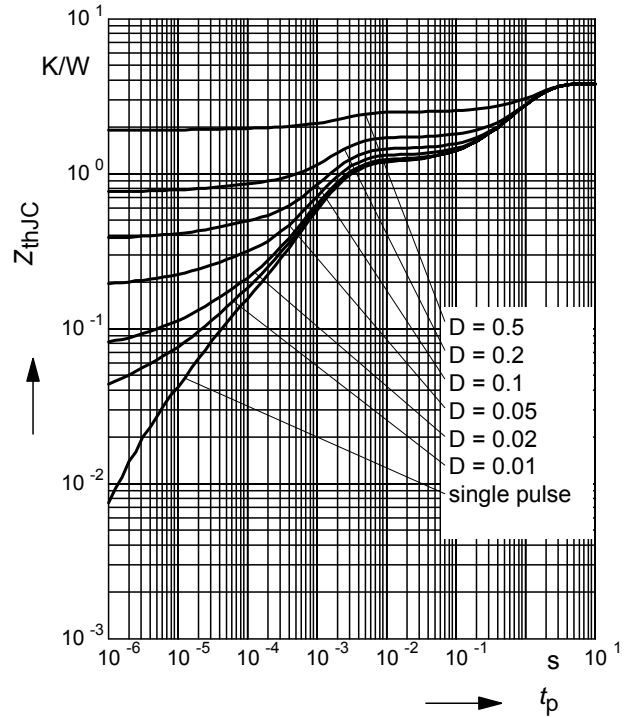
parameter:  $D = t_p/T$



**6 Transient thermal impedance FullPAK**

$Z_{thJC} = f(t_p)$

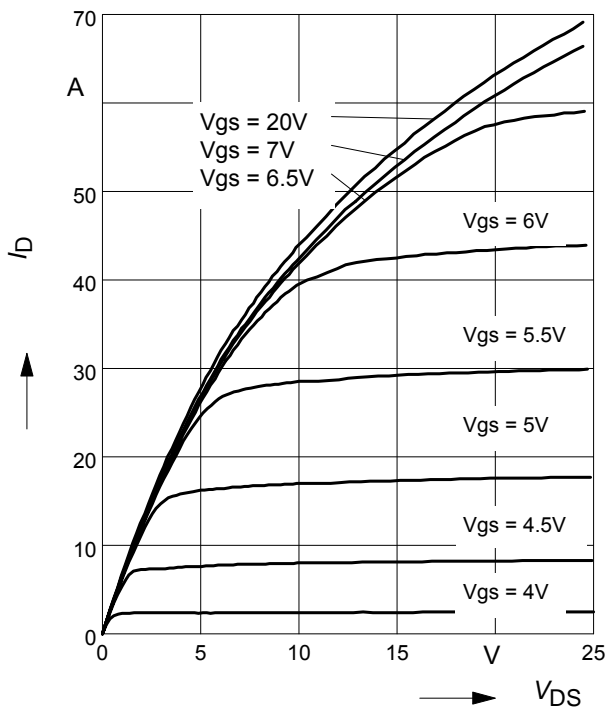
parameter:  $D = t_p/t$



**7 Typ. output characteristic**

$I_D = f(V_{DS}); T_j = 25^\circ C$

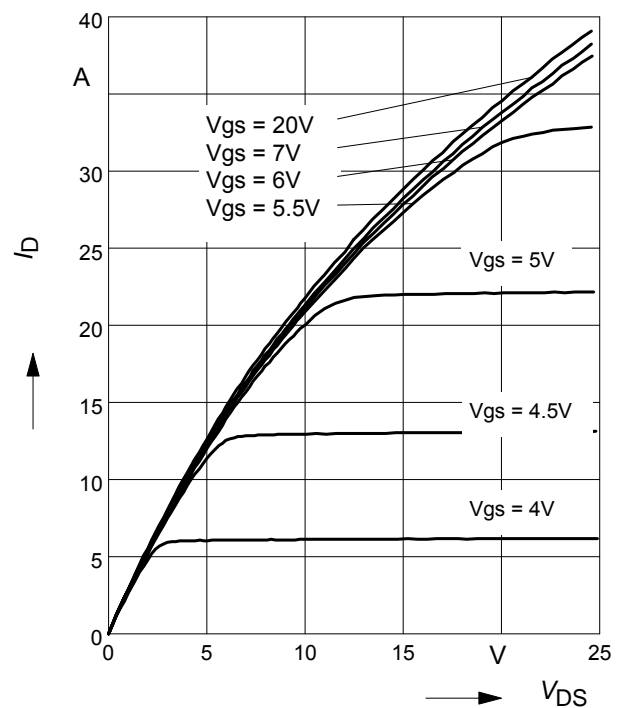
parameter:  $t_p = 10 \mu s, V_{GS}$



**8 Typ. output characteristic**

$I_D = f(V_{DS}); T_j = 150^\circ C$

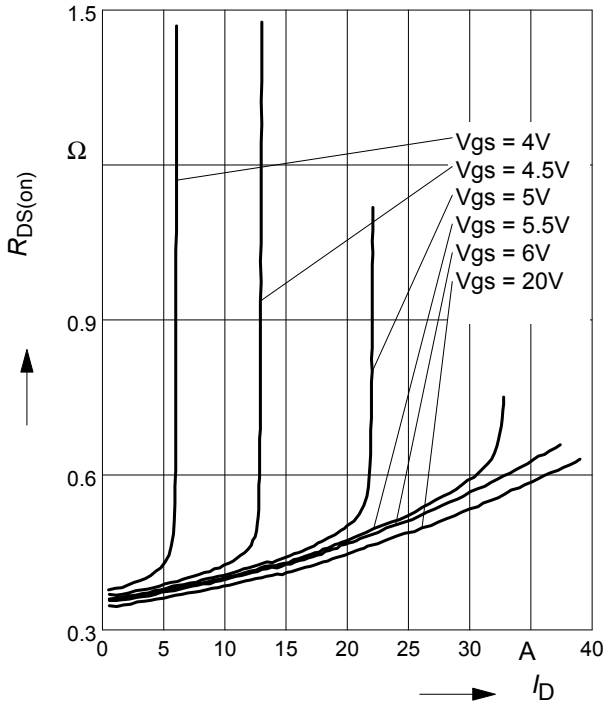
parameter:  $t_p = 10 \mu s, V_{GS}$



**9 Typ. drain-source on resistance**

$$R_{DS(on)} = f(I_D)$$

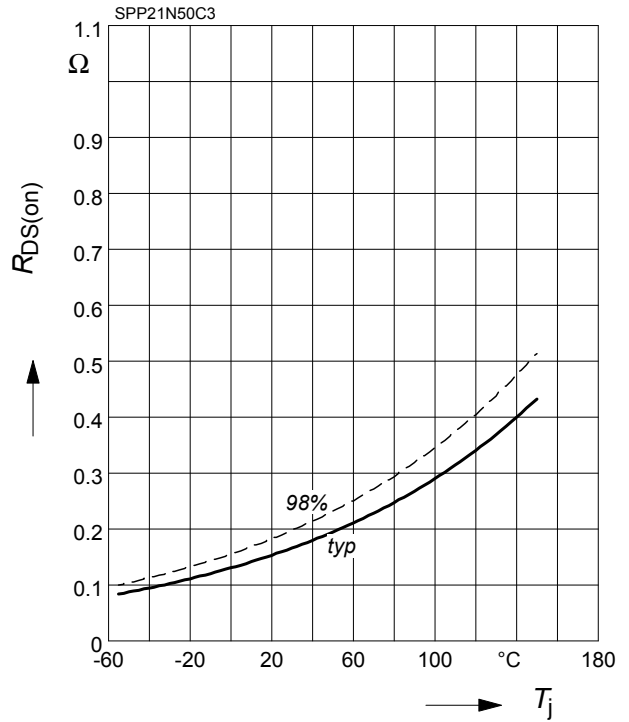
parameter:  $T_j = 150^\circ\text{C}$ ,  $V_{GS}$



**10 Drain-source on-state resistance**

$$R_{DS(on)} = f(T_j)$$

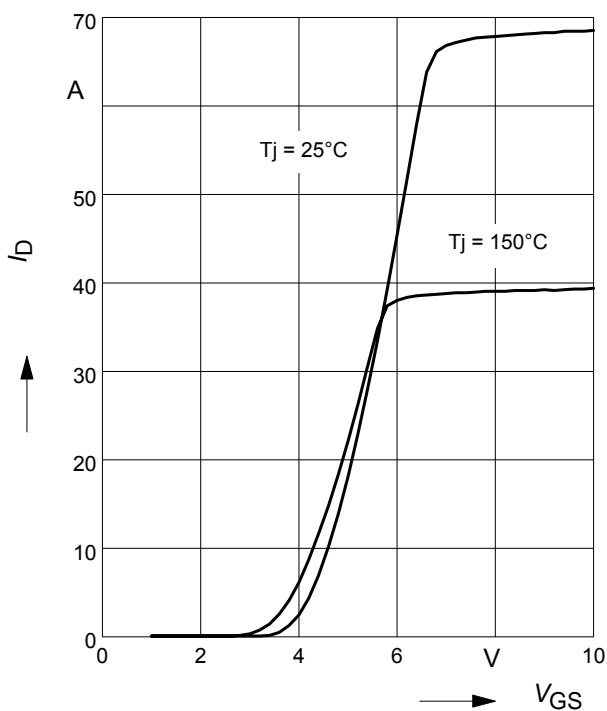
parameter:  $I_D = 13.1\text{ A}$ ,  $V_{GS} = 10\text{ V}$



**11 Typ. transfer characteristics**

$$I_D = f(V_{GS}); V_{DS} \geq 2 \times I_D \times R_{DS(on)max}$$

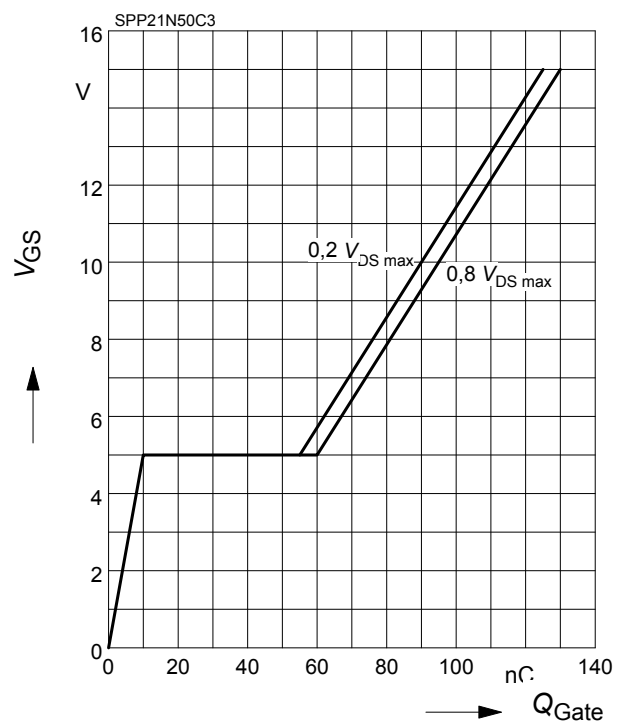
parameter:  $t_p = 10\ \mu\text{s}$



**12 Typ. gate charge**

$$V_{GS} = f(Q_{Gate})$$

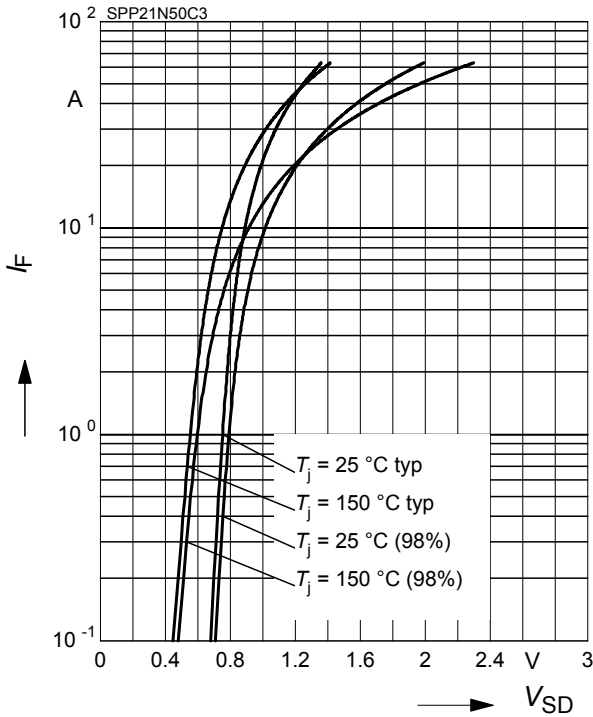
parameter:  $I_D = 21\text{ A pulsed}$



**13 Forward characteristics of body diode**

$$I_F = f(V_{SD})$$

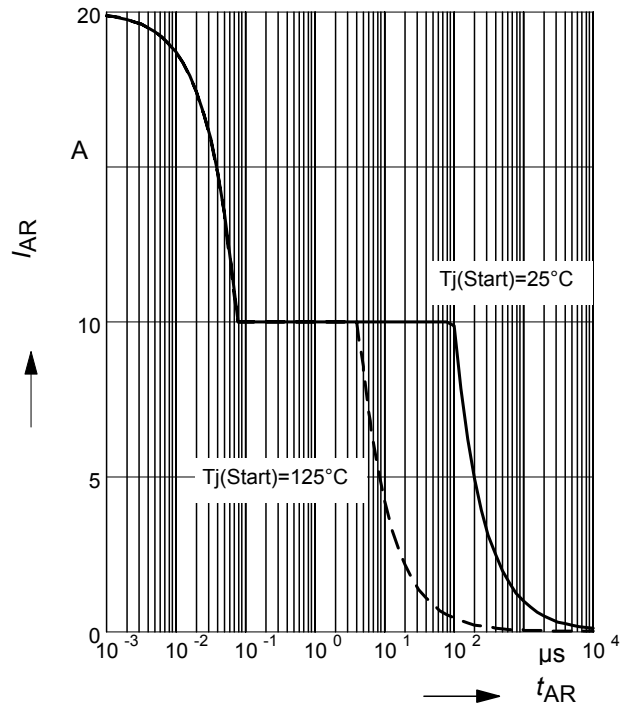
parameter:  $T_j$ ,  $t_p = 10 \mu s$



**14 Avalanche SOA**

$$I_{AR} = f(t_{AR})$$

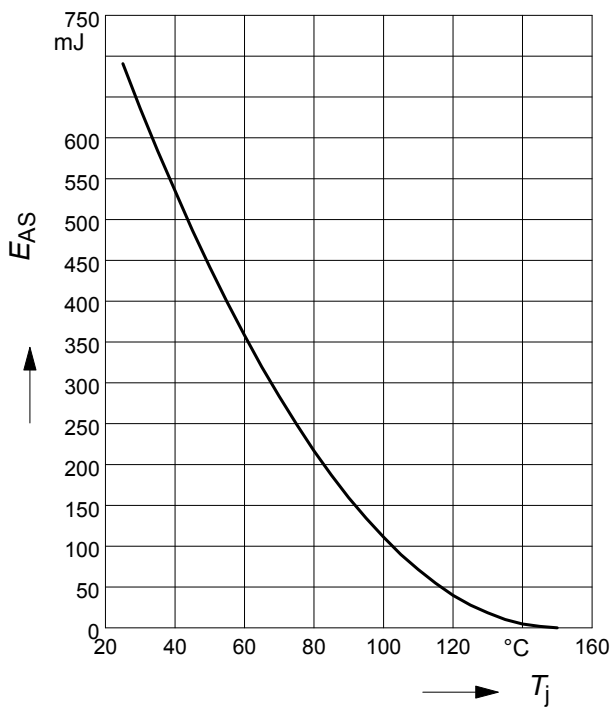
par.:  $T_j \leq 150 \text{ °C}$



**15 Avalanche energy**

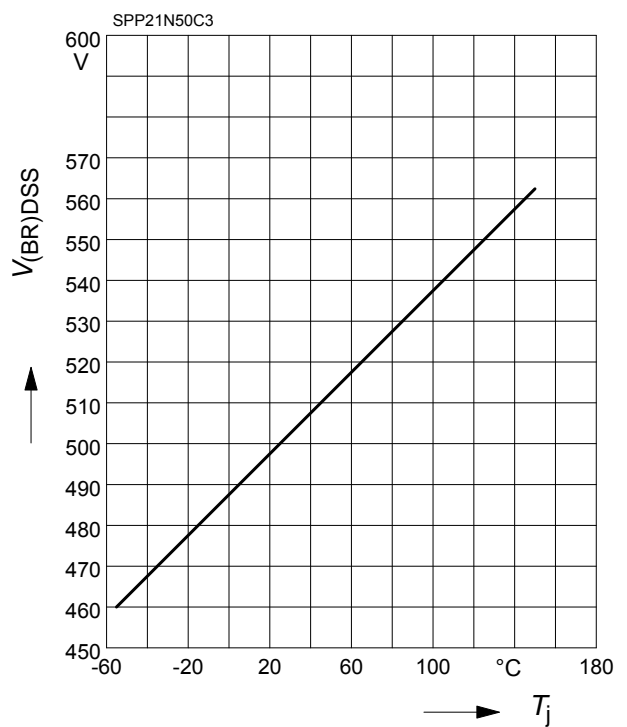
$$E_{AS} = f(T_j)$$

par.:  $I_D = 10 \text{ A}$ ,  $V_{DD} = 50 \text{ V}$



**16 Drain-source breakdown voltage**

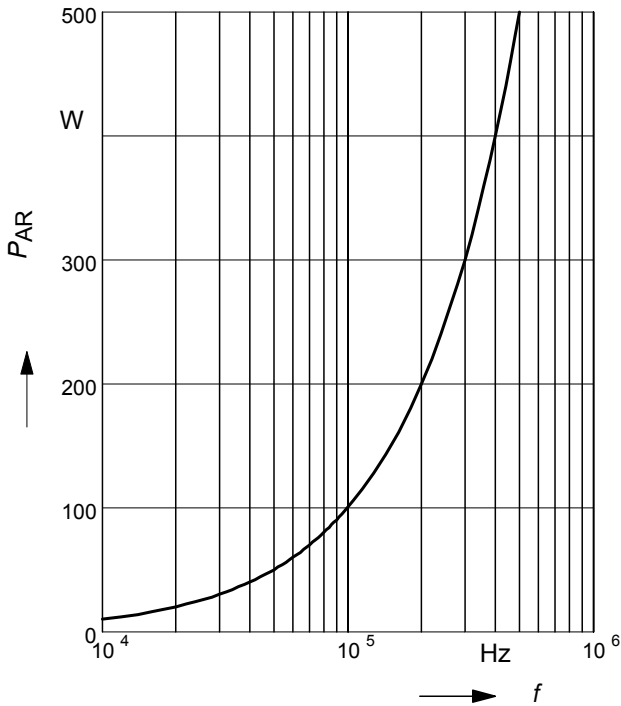
$$V_{(BR)DSS} = f(T_j)$$



**17 Avalanche power losses**

$$P_{AR} = f(f)$$

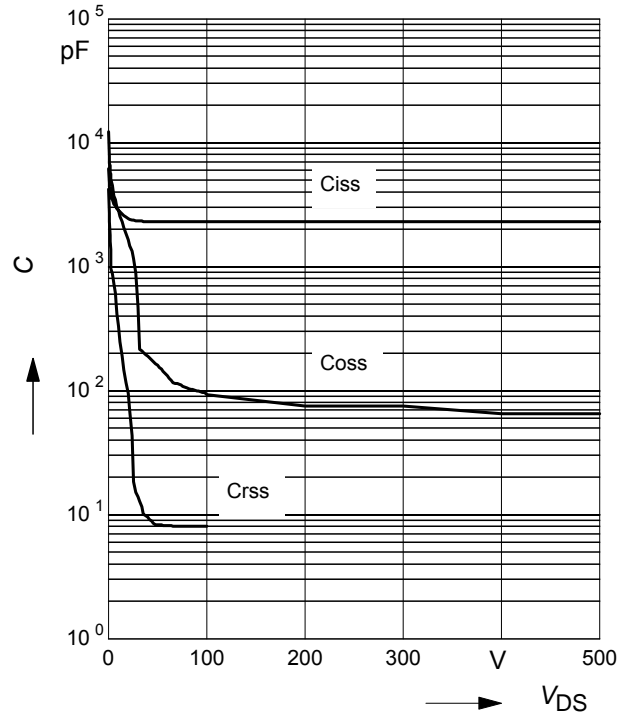
parameter:  $E_{AR}=1\text{mJ}$



**18 Typ. capacitances**

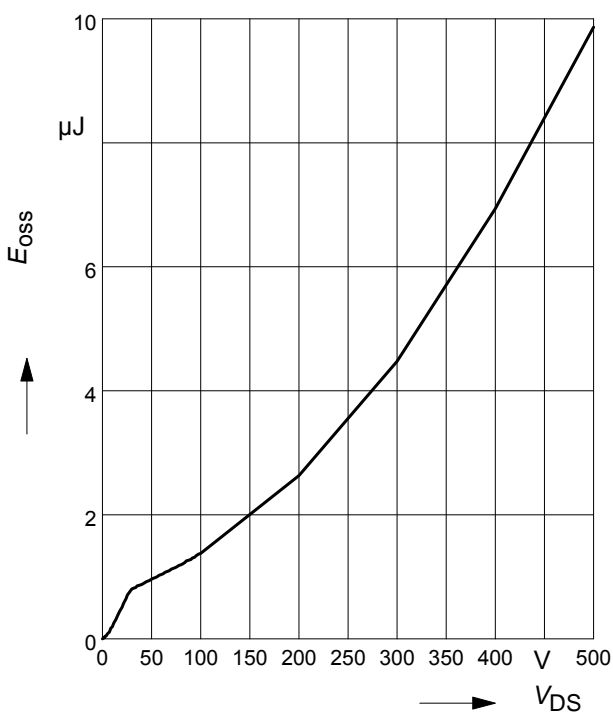
$$C = f(V_{DS})$$

parameter:  $V_{GS}=0\text{V}, f=1\text{ MHz}$

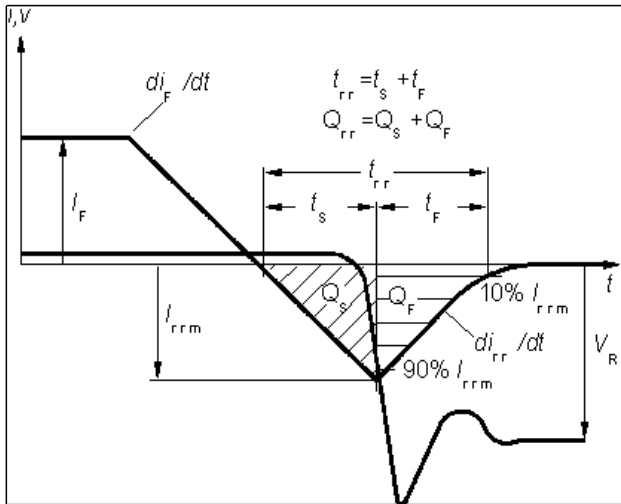


**19 Typ. C<sub>OSS</sub> stored energy**

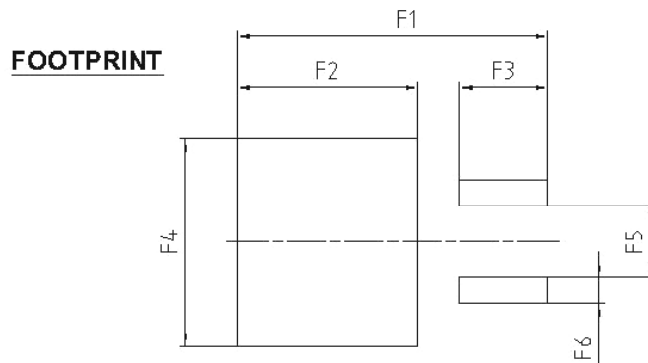
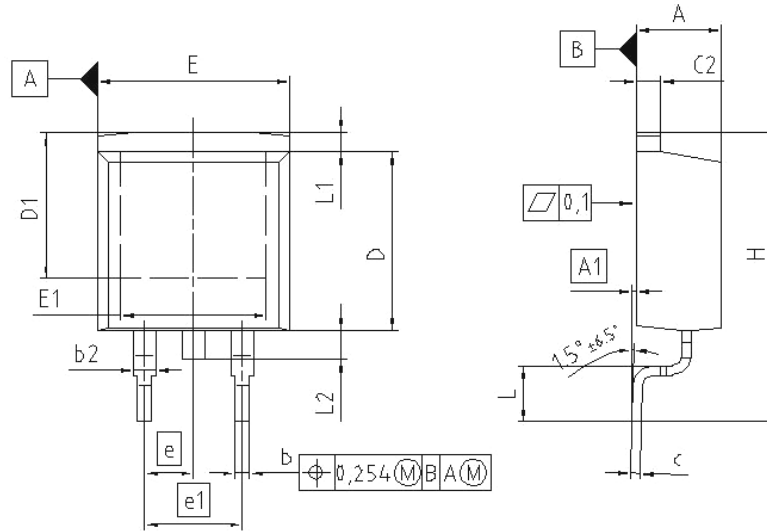
$$E_{OSS} = f(V_{DS})$$



Definition of diodes switching characteristics



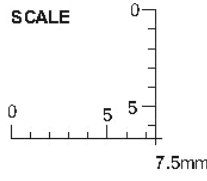
PG-TO263-3-2, PG-TO263-3-5, PG-TO263-3-22



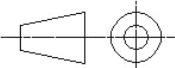
| DIM | MILLIMETERS |        | INCHES |       |
|-----|-------------|--------|--------|-------|
|     | MIN         | MAX    | MIN    | MAX   |
| A   | 4.300       | 4.572  | 0.169  | 0.180 |
| A1  | 0.000       | 0.254  | 0.000  | 0.010 |
| b   | 0.650       | 0.850  | 0.026  | 0.033 |
| b2  | 0.950       | 1.321  | 0.037  | 0.052 |
| c   | 0.330       | 0.650  | 0.013  | 0.026 |
| c2  | 0.170       | 1.400  | 0.046  | 0.055 |
| D   | 8.509       | 9.450  | 0.335  | 0.372 |
| D1  | 7.100       | -      | 0.280  | -     |
| E   | 9.800       | 10.312 | 0.386  | 0.406 |
| E1  | 6.500       | -      | 0.256  | -     |
| e   | 2.540       |        | 0.100  |       |
| e1  | 5.080       |        | 0.200  |       |
| N   | 2           |        | 2      |       |
| H   | 14.605      | 15.875 | 0.575  | 0.625 |
| L   | 2.200       | 3.000  | 0.087  | 0.118 |
| L1  | -           | 1.600  | -      | 0.063 |
| L2  | 1.000       | 1.778  | 0.039  | 0.070 |
| F1  | 16.050      | 16.250 | 0.632  | 0.640 |
| F2  | 9.300       | 9.500  | 0.366  | 0.374 |
| F3  | 4.500       | 4.700  | 0.177  | 0.185 |
| F4  | 10.700      | 10.900 | 0.421  | 0.429 |
| F5  | 3.630       | 3.830  | 0.143  | 0.151 |
| F6  | 1.100       | 1.300  | 0.043  | 0.051 |

**REFERENCE**  
JEDEC TO263

**SCALE**



**EUROPEAN PROJECTION**



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**FILE**  
TO263\_2

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